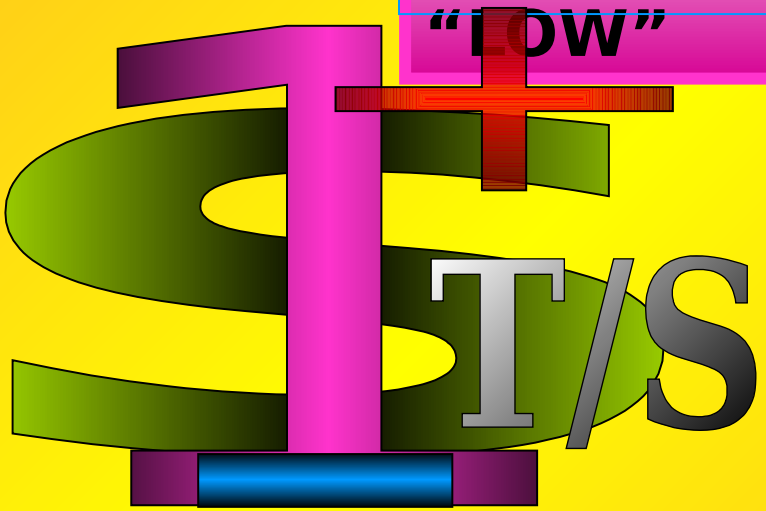
DC:

SERIES CIRCUITS TroubleShooting

Unclassified:

3 Hour Conference W/3Hr. PE1

Safety & Environmental Impact: “LOW”



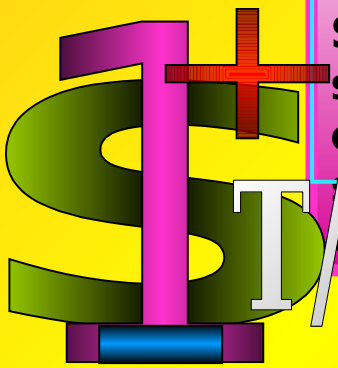
DC: Series Circuits Trouble Shooting

Terminal Learning Objective

ACTION: Locate a malfunction in a series circuit.

CONDITION: Given a classroom environment, Computer Aided Instruction (CAI) workstation, NIDA 130A electronics trainer, digital Multimeter w/test leads, PC-130-6A and PC-130-6B circuit cards, schematic diagrams, calculator and official OMEMS reference materials.

STANDARD: Be able to locate and identify an open, short, or changed value malfunction within a series circuit using proper procedures to the established standard to a minimum of 7 correct answers out of 10 & 8 out of 10 for EOD.



DC: Series Circuits Trouble Shooting

Introduction

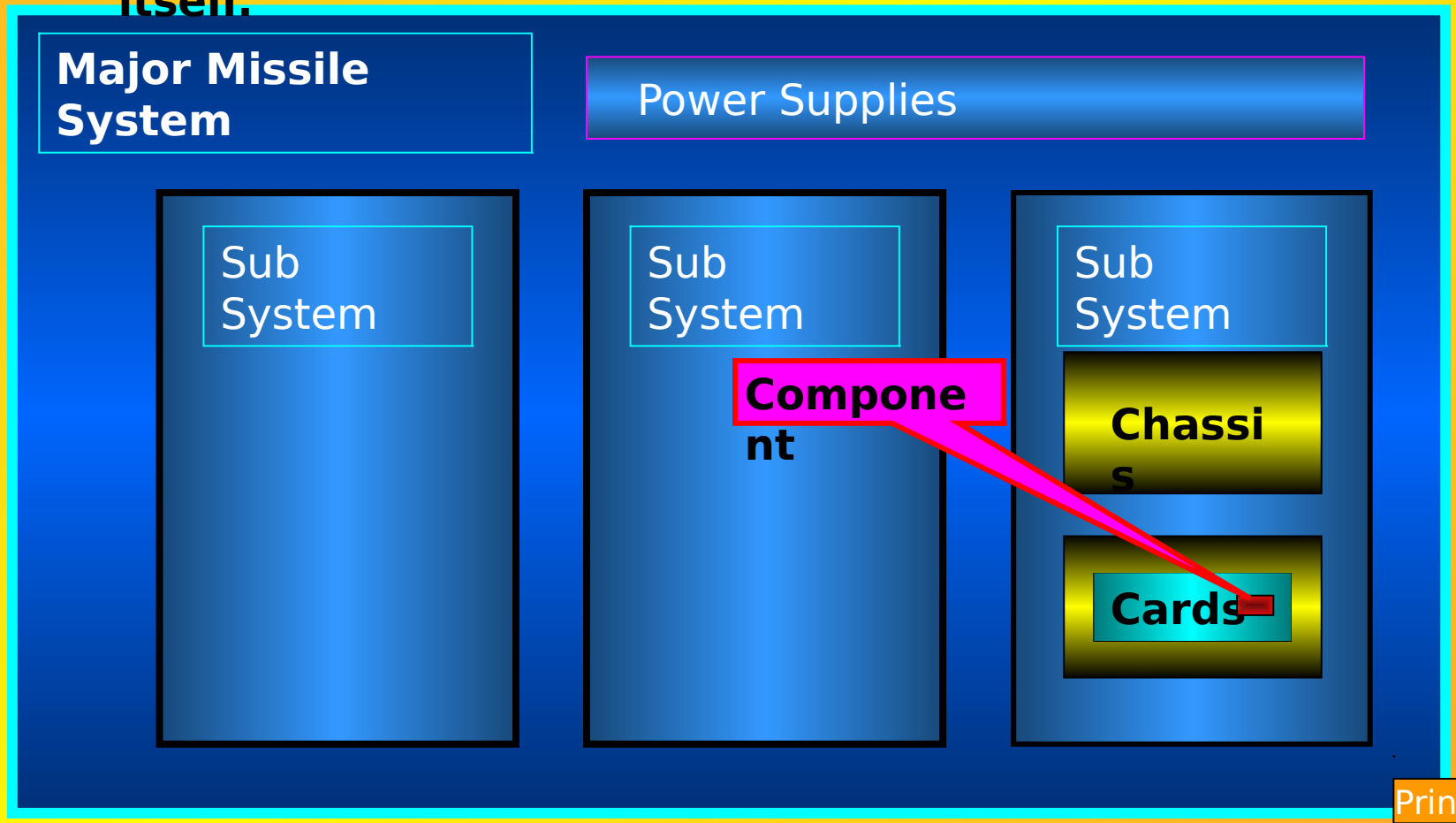
The 2nd law of Thermal Dynamics dictates that all matter breaks down to a simpler form and heat increases the rate of the breakdown.

As a technician the process of making a diagnosis from the symptoms that occur and correcting the malfunction, is instrumental part of maintenance.

Ohm's Law, Kirchoff's Law & Series Ckts concepts are used to find the normal operating parameters, & will be the point of reference & comparison use in the diagnosis and repair of a Malfunction.

DC: Series Circuits Trouble Shooting

Locating a malfunction W/in a Major System requires a logical breakdown of all its many Chassis, Cards, Ckts then down to the Component itself.



Principals

DC: Series Circuits Troubleshooting

4 basic principles in the approach to troubleshooting:

Visualize, Sectionalize, Localize, Isolate.

Visualization; your perception & keen observation is one of the most useful tools of maintenance. This ability serves to confirm and or eliminate indications that lead to the malfunction.

Lights not lit

Fuses blown [opened]

Interlock Switches not set, [Opened]

Cracked printed Ckt card runs

Loose or inadequate bonded solder joints [cold joints]

Components discolored, swollen or cracked

Burnt smell

Hot [check W/power off]

Terms

DC: Series Circuits Trouble Shooting

Terms:

Symptom: A measurement or an obvious indication, which when compared to the normal, is outside or contrary to its normal operating parameters.

Malfunction: Is simply defined based on the symptoms as an Open, Short, or Changed value.

Open: A component is said to be Open when it no longer allows conduction or provides a current flow. The path has been severed in that component or Ckt.

Short: Is the opposite of an open, The component or Ckt becomes a free path for current flow W/O the normal opposition offered by the designed characteristics of the component. The device acts like a piece of wire.

Changed Value: Occurs when a component operates outside of it's specified value & tolerance.

Matrix

DC: Series Circuits Trouble Shooting

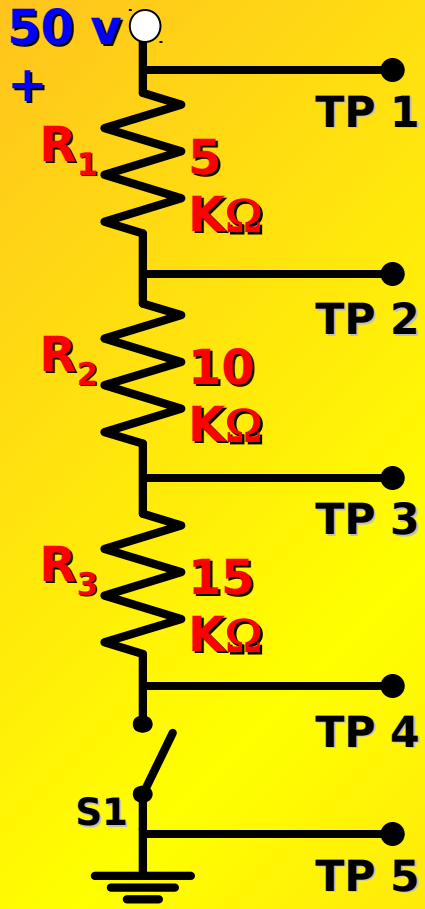
Open & Shorts defined W/Measurements:

	OPEN	SHORT
E	$E_{R\#}$ ⇑ to = E_A	$E_{R\#}$ ⇓ to = 0 v
I	I_T ⇓ to = 0 Amps	I_T ⇑
R	$R_{\#}$ ⇑ to = ∞ Ω	$R_{\#}$ ⇓ to = 0 Ω

Challenge

DC: Series Circuits Trouble Shooting

Calculate for the Normals:



E_A = ____

R_T = ____

I_T = ____

E_{R1} = ____

E_{R2} = ____

E_{R3} = ____

E_{TP1} = ____

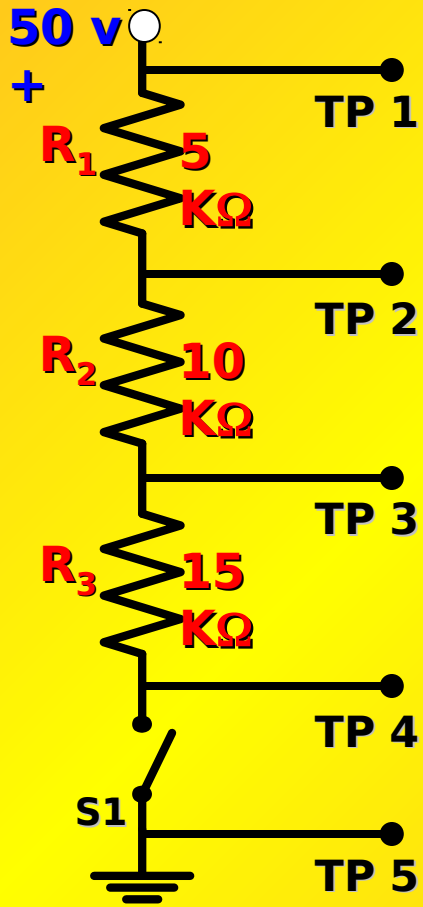
E_{TP2} = ____

E_{TP3} = ____

Answers

DC: Series Circuits T/S

Check, Answers



E_A = 50 v

R_T = 30 KΩ

I_T = 1.66 mA

= 8.35 v

E_{R1} = 16.7 v

E_{R2} = 24.9 v

E_{R3}

= 50 v

= 41.5 v

E_{TP1}

= 24.9 v

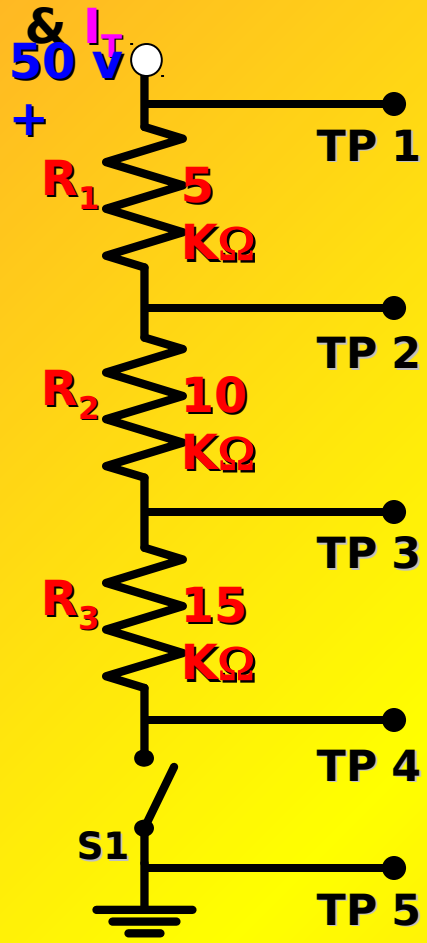
E_{TP2}

E

RT, IT relationship

DC: Series Circuits T/S, Open / Short

Resistance & the Relationship of R_T & I_T

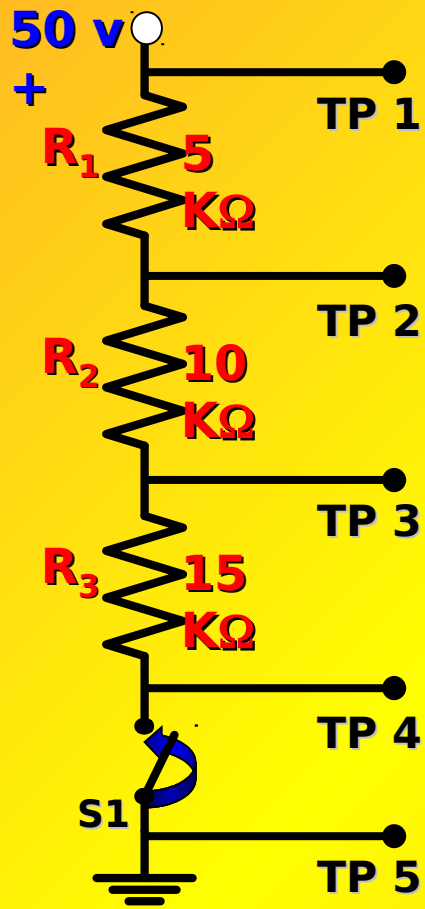


Normal	OPEN	SHORT
E_S = 50 v	same	same
R_T = 30 KΩ	⇑ = ∞ Ω	⇓ Ω Not to 0
I_T = 1.66 mA	⇓ = 0 A	⇑ mA
= 5 KΩ	⇑ = ∞ Ω	⇓ = 0 Ω
R_1 = 10 KΩ	⇑ = ∞ Ω	⇓ = 0 Ω
R_2 = 15 KΩ	⇑ = ∞ Ω	⇓ = 0 Ω
R_3		

Voltage Drops

DC: Series Circuits T/S, Open / Short

Voltage Drops:



Normals		OPEN	SHORT
E_A	= 50 v	same	same
R_T	= 30 KΩ	▯ = ∞ Ω	▯ Ω
I_T	= 1.66 mA	▯ = 0 A	▯ mA

	OPEN	SHORT
= 8.35 v	▯ = EA	▯ = 0v
E_{R1} = 16.7 v	▯ = EA	▯ = 0v
E_{R2} = 24.9 v	▯ = EA	▯ = 0v
E_{R3}		

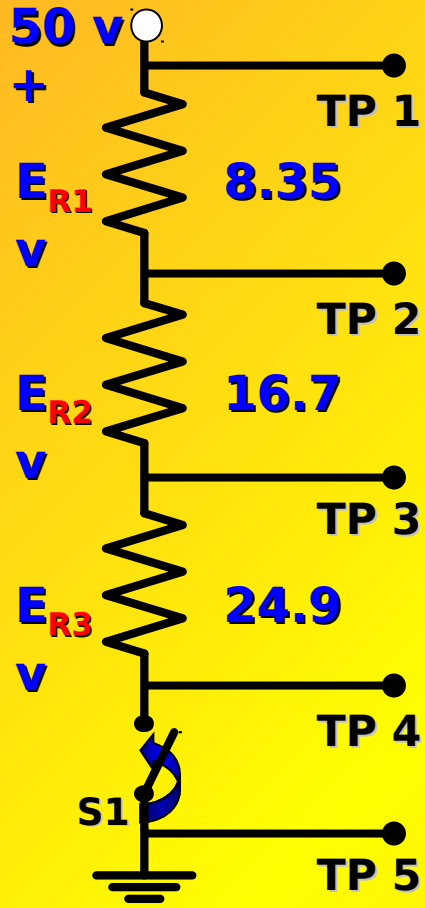
OPEN: The meter completes the Ckt thus all voltage is dropped across the meter.

SHORT: The component acts like a piece of wire, No opposition to current, No voltage Drop.

Challenge

DC: Series Circuits T/S, Open / Short

Voltage Drops: Determine the Defective Component & Malfunction



A.

E_{R1} = 50v $R_{\#}$?

E_{R2} = 0v R_T ?

E_{R3} = 0v I_T ?

Clue:

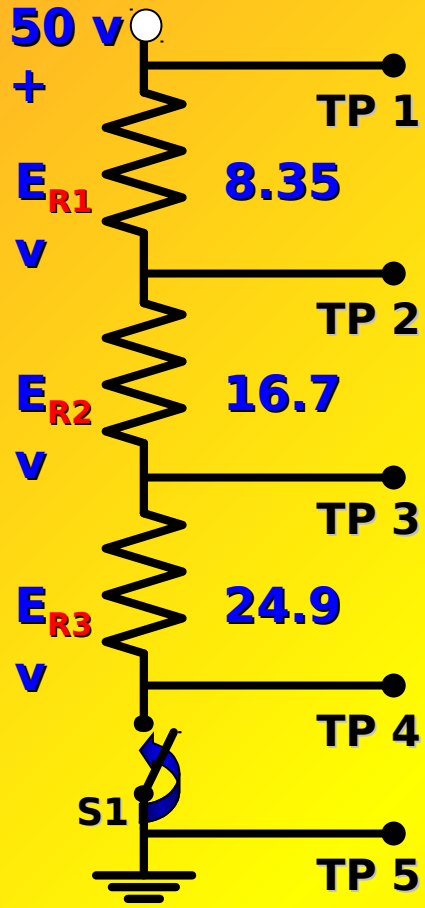
Which one of these things is not like the other, Which one of these things is not the Same ?

Series	OPEN	SHORT
E	$E_{R\#}$ ▯ to = E_A	$E_{R\#}$ ▯ to = 0
V		
I	I_T ▯ to = 0 A	I_T ▯
R Ω	$R_{\#}$ ▯ to = ∞ Ω	$R_{\#}$ ▯ to = 0

B. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage Drops: Determine the Defective Component & Malfunction



B.

E_{R1} = 10v

$R_{\#}$?

E_{R2} = 40v

R_T ?

E_{R3} = 0v

I_T ?

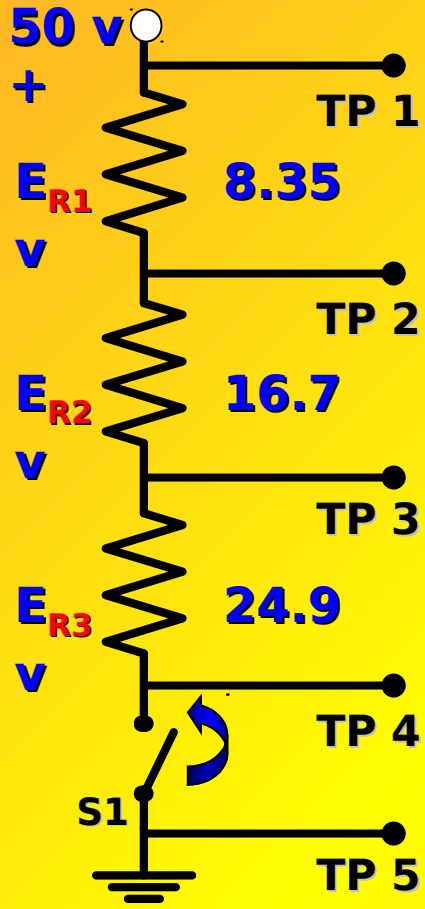
Clue: Which one of these things is not like the other, Which one of these things is not the Same ?

Series	OPEN	SHORT
E	$E_{R\#}$ ▯ to = E_A	$E_{R\#}$ ▯ to = 0
v		
I	I_T ▯ to = 0 A	I_T ▯
R Ω	$R_{\#}$ ▯ to = ∞ Ω	$R_{\#}$ ▯ to = 0

C. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage Drops: Determine the Defective Component & Malfunction



C.

E_{R1} = 0v

$R_{\#}$?

E_{R2} = 50v

R_T ?

E_{R3} = 0v

I_T ?

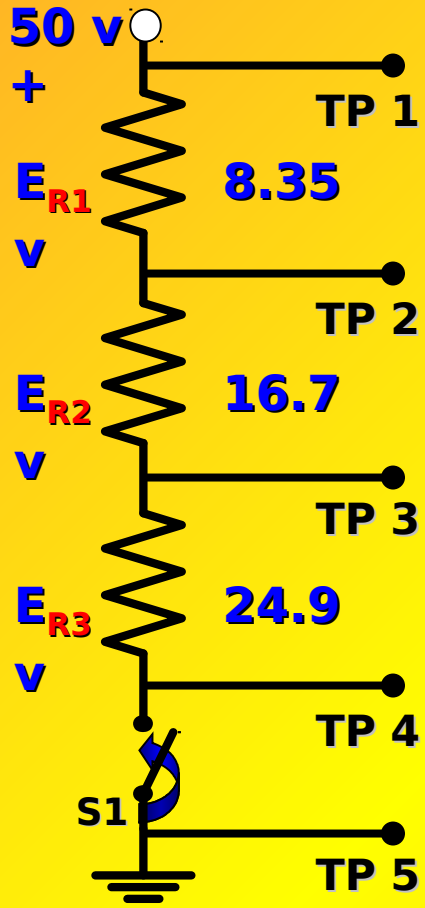
Clue: Which one of these things is not like the other, Which one of these things is not the Same ?

Series	OPEN	SHORT
E	$E_{R\#}$ ▯ to = E_A	$E_{R\#}$ ▯ to = 0
v		
I	I_T ▯ to = 0 A	I_T ▯
R Ω	$R_{\#}$ ▯ to = ∞ Ω	$R_{\#}$ ▯ to = 0

D. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage Drops: Determine the Defective Component & Malfunction



D.

E_{R1} = 0v

$R_{\#}$?

E_{R2} = 20v

R_T ?

E_{R3} = 30v

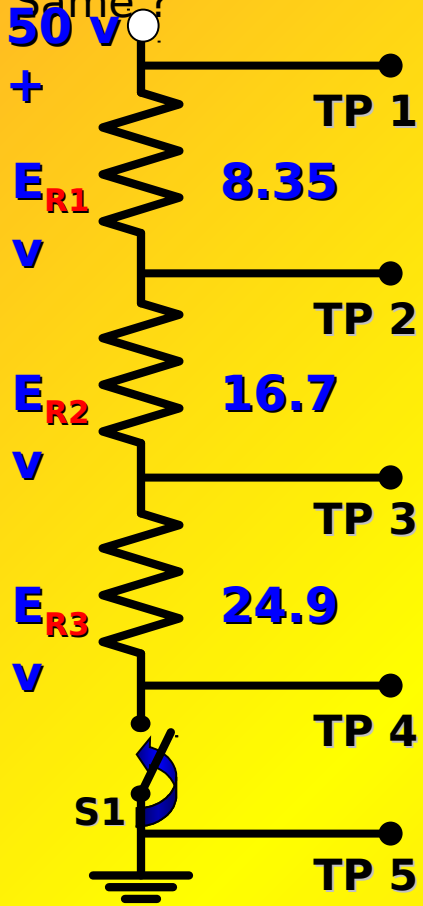
Series Circuit	OPEN?	SHORT
E	$E_{R\#}$ ▯ to = E_A	$E_{R\#}$ ▯ to = 0
v		
I	I_T ▯ to = 0 A	I_T ▯
R Ω	$R_{\#}$ ▯ to = ∞ Ω	$R_{\#}$ ▯ to = 0

A-D Review

DC: Series Circuits T/S, Open / Short

Voltage Drops:
Answers

Clue: Which one of these things is not like the other, Which one of these things is not the Same ?



OPEN	
E	$E_{R\#}$ ▯ to = E_A
I	I_T ▯ to = 0 A
R	$R_\#$ ▯ to = ∞ Ω
SHORT	
E	$E_{R\#}$ ▯ to = 0 v

A.
E_{R1} = 50v
E_{R2} = 0v
E_{R3} = 0v
R_T ⇑
I_T ▯

B. OPEN
E_{R1} = 10v
E_{R2} = 40v
E_{R3} = 0v
R_T ▯
I_T ▯

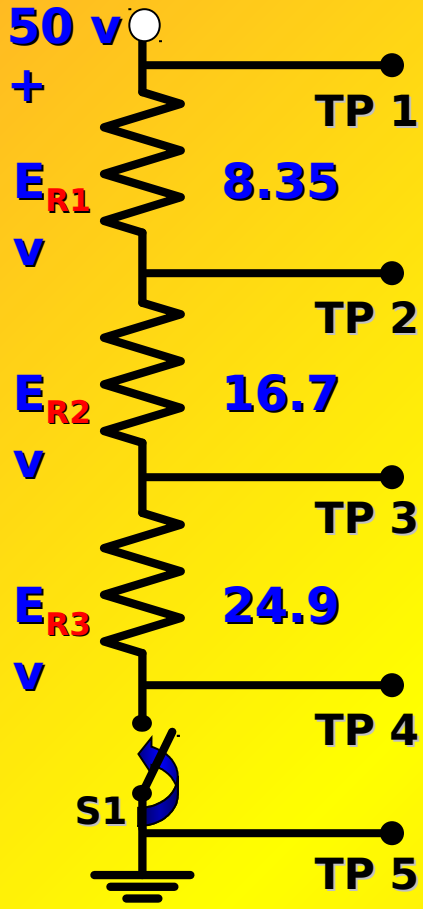
C. Short
E_{R1} = 0v
E_{R2} = 50v
E_{R3} = 0v
R_T ▯
I_T ▯

D. OPEN
E_{R1} = 0v
E_{R2} = 20v
E_{R3} = 30v
Short
R_T ▯
I_T ▯

V @ TP

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points:



Voltage @ Test Points are made in reference to Gnd, and is the Sum of the Voltage Drops between the T/P & Gnd.

Bracket & Subtract Method:

Is the <u>difference</u> of Voltage, between two TP, thus reducing them to a Voltage Drop.

E_{TP1} = 50 v
E_{TP2} = 41.5 v
E_{TP3} = 24.9 v
Gnd, 0v

$E_{TP1} - E_{TP2} = E_{R1} = 8.35$ v

$E_{TP2} - E_{TP3} = E_{R2} = 16.7$ v

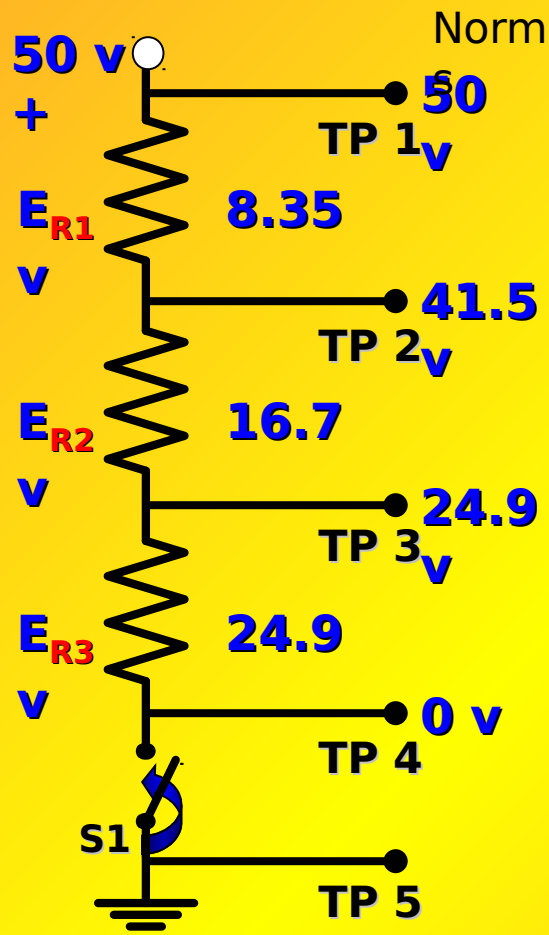
$E_{TP3} - Gnd = E_{R3} = 24.9$ v

Once the voltage Drops have been Determined, comparing them w/each other would determine which <u>Voltage Drop</u> is unlike the others.

Challenge

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: From the given Voltages @ Test Points determine the Defective Component & Malfunction. [Bracket & Subtract]



E_{TP1} = 50 v } = E_{R1}

E_{TP2} = 41.5 v } = E_{R2}

E_{TP3} = 24.9 v } = E_{R3}

Gnd, 0v

A. **Symptoms**

E_{TP1} = 50 v ____

E_{TP2} = 50 v ____

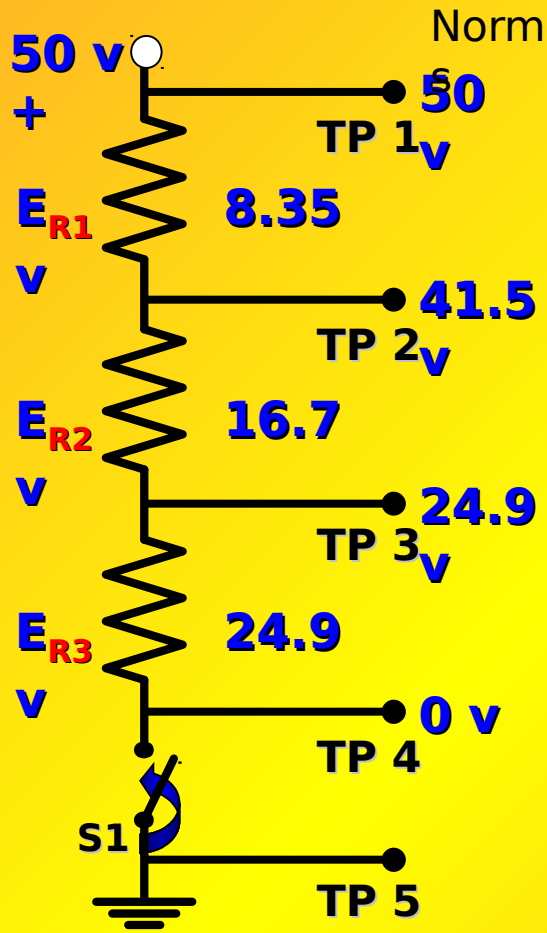
E_{TP3} = 50 v ____

Ground

B. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: From the given Voltages @ Test Points determine the Defective Component & Malfunction. [Bracket & Subtract]



E_{TP1} = 50 v
E_{TP2} = 41.5 v = E_{R1}
E_{TP3} = 24.9 v = E_{R2}
Gnd, 0v = E_{R3}

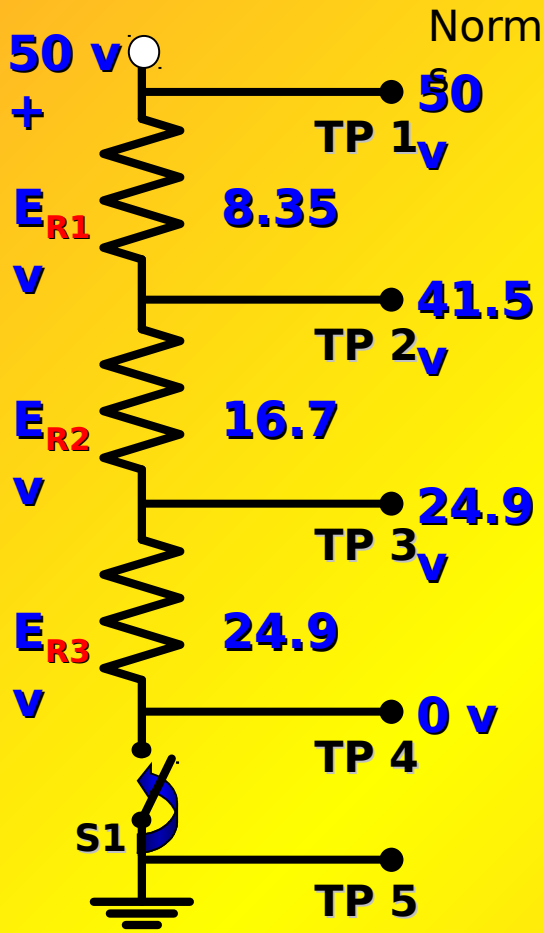
B. Symptoms

E_{TP1} = 50 v
E_{TP2} = 50 v
E_{TP3} = 0 v
Ground

C. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: From the given Voltages @ Test Points determine the Defective Component & Malfunction. [Bracket & Subtract]



E_{TP1} = 50 v
E_{TP2} = 41.5 v . = E_{R1}
E_{TP3} = 24.9 v . = E_{R2}
Gnd, 0v . = E_{R3}

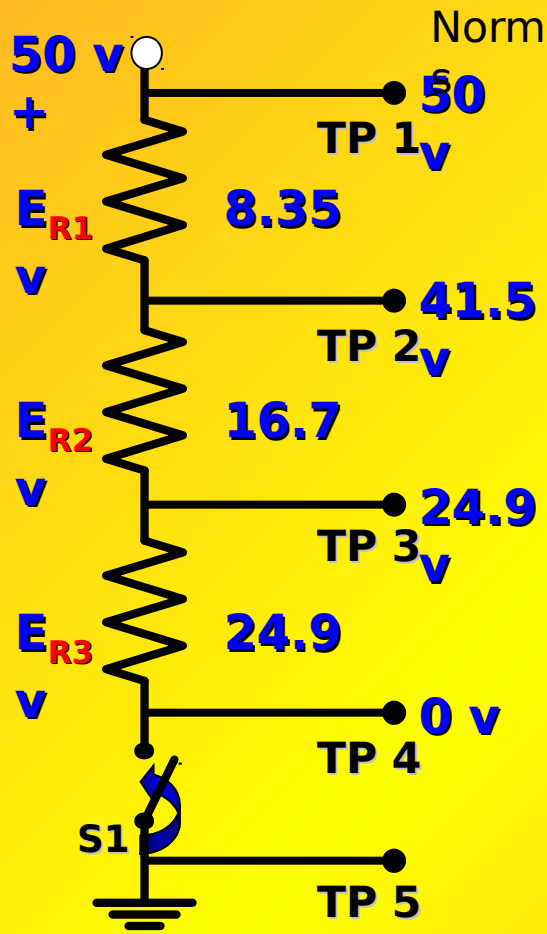
C. Symptoms

E_{TP1} = 50 v
E_{TP2} = 50 v
E_{TP3} = 37.5
Ground

D. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: From the given Voltages @ Test Points determine the Defective Component & Malfunction. [Bracket & Subtract]



E_{TP1} = 50 v
E_{TP2} = 41.5 v
E_{TP3} = 24.9 v
Gnd, 0v

= E_{R1}
= E_{R2}
= E_{R3}

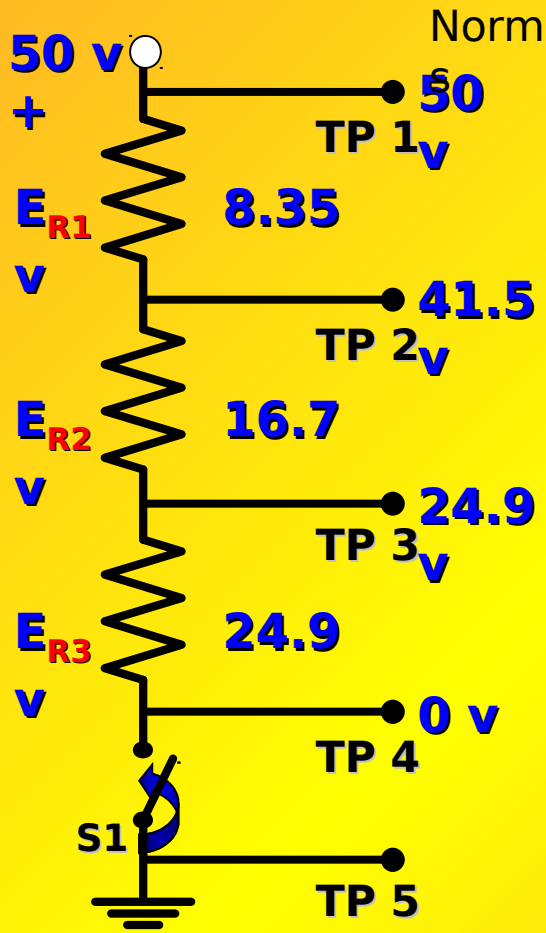
D. Symptoms

E_{TP1} = 50 v
E_{TP2} = 30 v
E_{TP3} = 30 v
Ground

E. Challenge

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: From the given Voltages @ Test Points determine the Defective Component & Malfunction. [Bracket & Subtract]



E_{TP1} = 50 v
E_{TP2} = 41.5 v
E_{TP3} = 24.9 v
Gnd, 0v
= E_{R1}
= E_{R2}
= E_{R3}

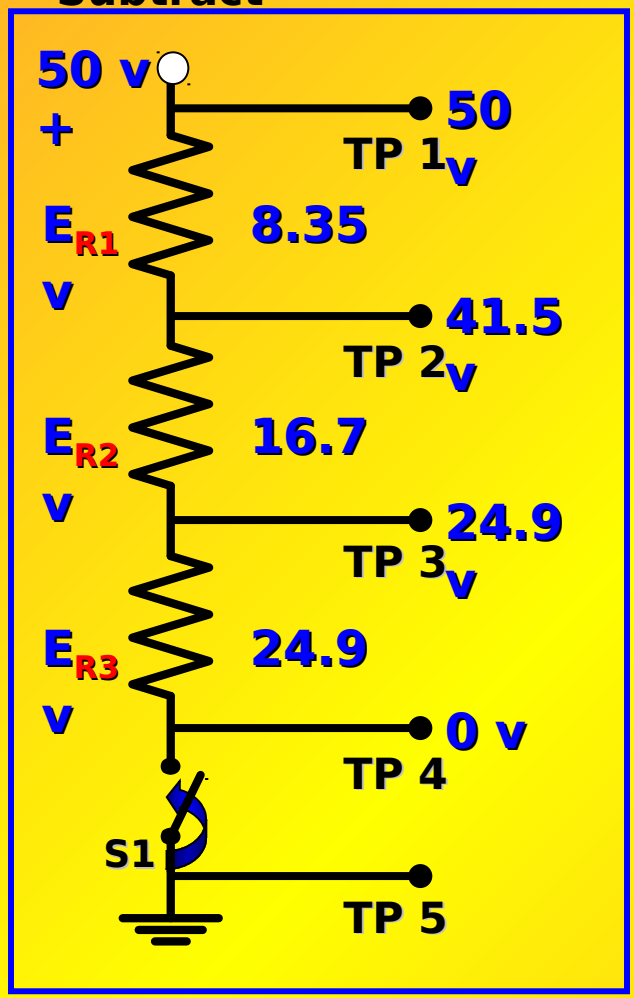
E. Symptoms

E_{TP1} = 50 v
E_{TP2} = 28.8
E_{TP3} = 0v
Ground

All Answers

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: From the given Voltages @ Test Points determine the Defective Component & Malfunction. Bracket & Subtract



E_{TP1} = 50 v
E_{TP2} = 41.5 v
E_{TP3} = 24.9 v
Gnd, 0v

= E_{R1}
= E_{R2}
= E_{R3}

A.

E_{TP1}	= 50 v	0v
E_{TP2}	= 50 v	0v
E_{TP3}	= 50 v	50 v
R_3	Gnd	
Opn		

B.

E_{TP1}	= 50 v	0v
E_{TP2}	= 50 v	50 v
E_{TP3}	= 0 v	0v
R_2	Gnd	
Opn		

C.

E_{TP1}	= 50 v	0v
E_{TP2}	= 50 v	12.5
E_{TP3}	= 37.5	37.5
R_1	Gnd	
Shrt		

D.

E_{TP1}	= 50 v	20v
E_{TP2}	= 30 v	0 v
E_{TP3}	= 30 v	30v
R_2	Gnd	
Shrt		

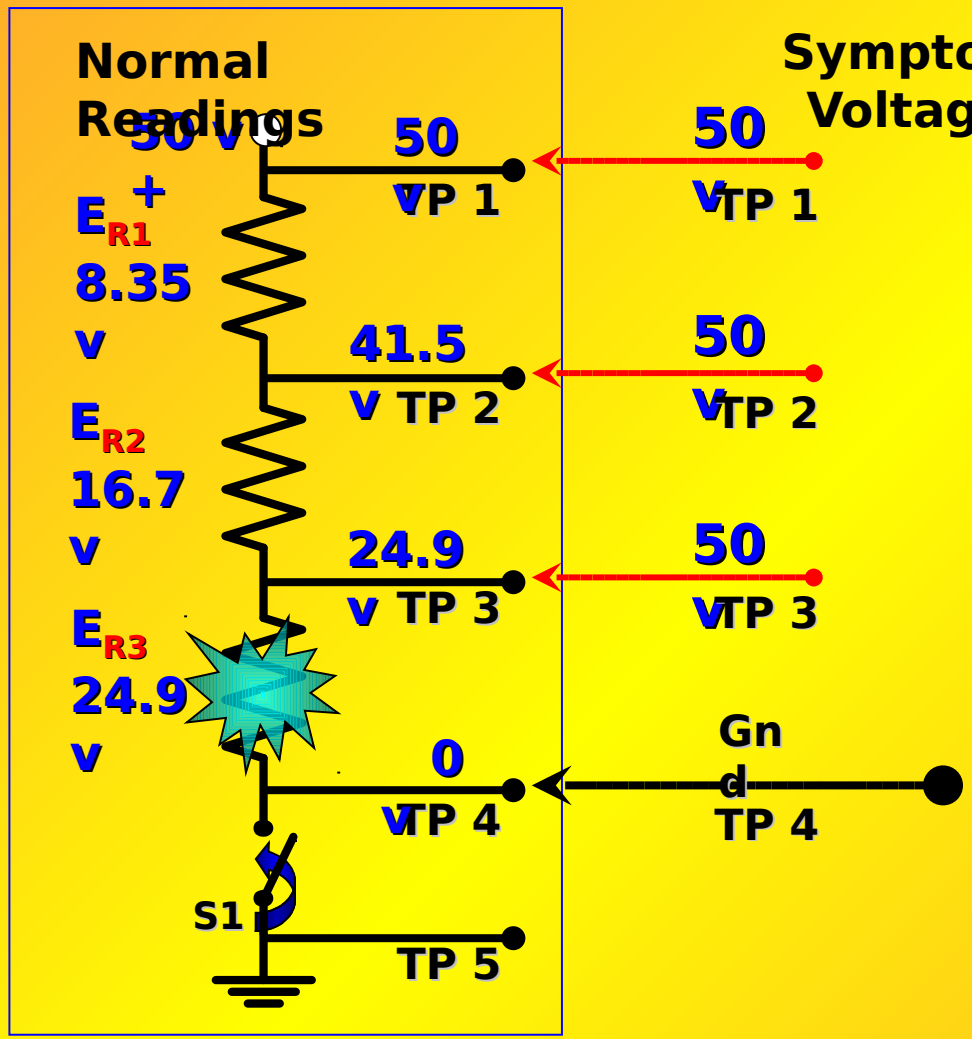
E.

E_{TP1}	= 50 v	21.2
E_{TP2}	= 28.8	28.8
E_{TP3}	= 0 v	0 v
R_3	Gnd	
Shrt		

Analysis of A

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: Analysis.



A.

E_{TP1} = 50 v
E_{TP2} = 50 v
E_{TP3} = 50 v
Gnd

0v
0v
50 v

R_3 Open

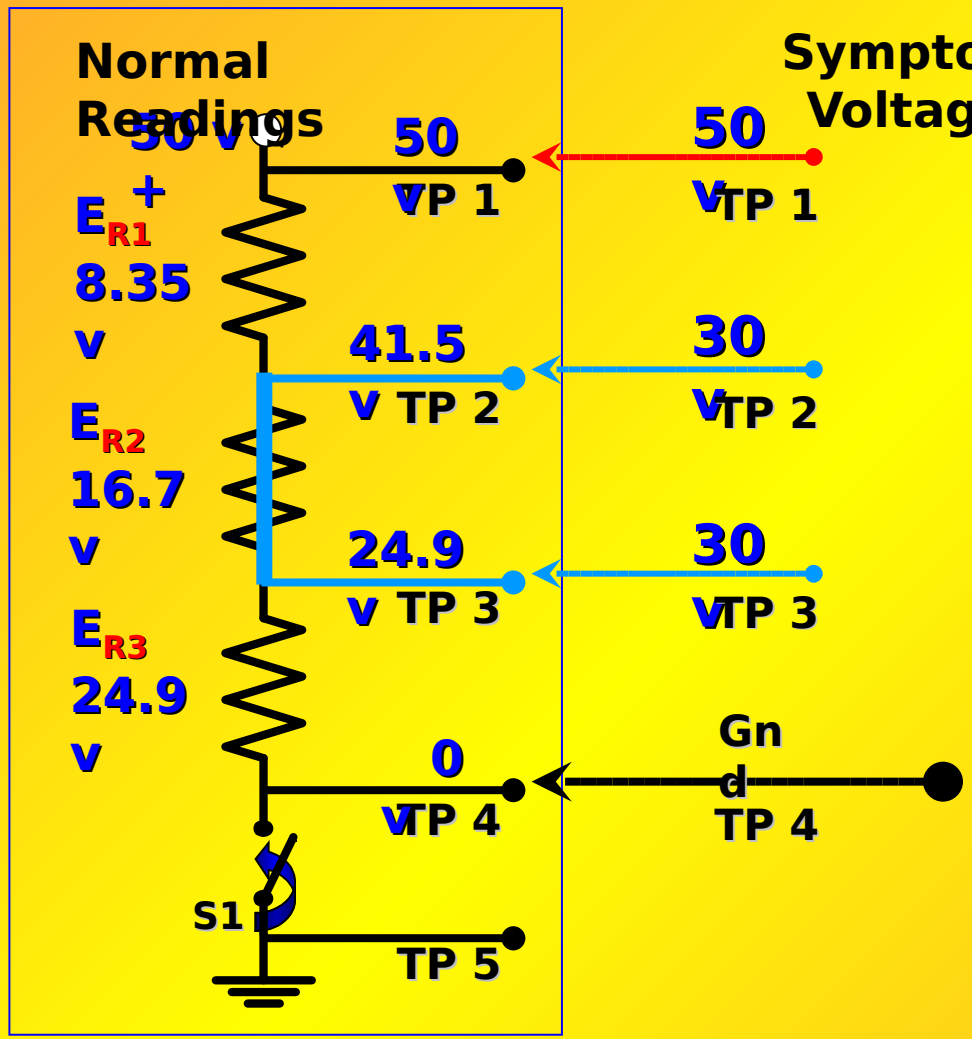
In reference to Gnd, starting @ TP 3, the reading is across R_3, it is the only component between the TP an Gnd, we Read E_{R3} it = 50 v, or EA, this Indicates R_3 is OPEN.

@ TP 2 We are still reading across R_3 OPEN even though R_2 is also bracketed between the leads.

@ TP 1 we are still meas... across an OPEN, it = EA.

DC: Series Circuits T/S, Open / Sho

Voltage @ Test Points: Analysis.



D.

E_{TP1} = 50 v — 20v

E_{TP2} = 30 v — 0 v

E_{TP3} = 30 v — 30v

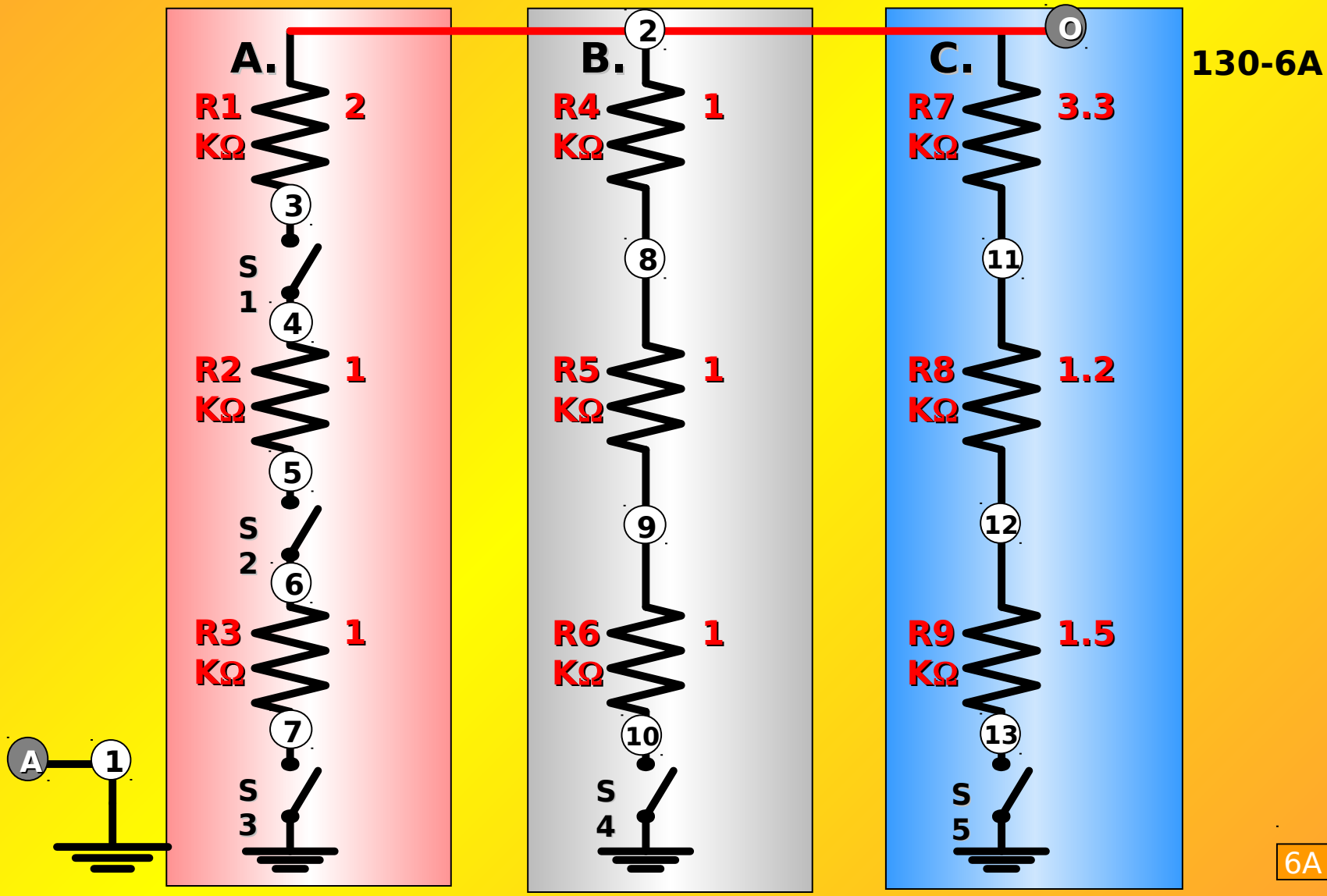
Gnd

R_2 SHORT

to Gnd, starting @ TP 3, the reading is across R_3, it reads 30v and is the only component between the TP an Gnd.

@ TP 2 We read across R_3 and R_2. It should have an increase in voltage because of the opposition of R_2 has been added to the measurement, [R ⇑, E ▯] Instead the same voltage is evident @TP 2 as was TP 3. TP 3 & TP 2 are the same point electrically, both

DC: Series Circuits T/S, PE



6A Card

DC: Series Circuits Trouble Shooting

Lesson Test:

Standard: 10 Questions W/in 20 minutes 70% Minimum Accuracy. 80% for EOD.

Reference: Official OMEMS Training Aids

PE Malfunction entry procedure